

PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : C06B 45/04, 25/34, F42B 1/02	A1	(11) International Publication Number: WO 98/49123 (43) International Publication Date: 5 November 1998 (05.11.98)
(21) International Application Number: PCT/SE98/00775 (22) International Filing Date: 28 April 1998 (28.04.98) (30) Priority Data: 9701622-4 29 April 1997 (29.04.97) SE (71) Applicant (for all designated States except US): FÖRSVARETS FORSKNINGSANSTALT [SE/SE]; S-172 90 Stockholm (SE). (72) Inventors; and (75) Inventors/Applicants (for US only): LANGLET, Abraham [SE/SE]; Surbrunnsgatan 33, S-113 48 Stockholm (SE). ÖSTMARK, Henric [SE/SE]; Bergmarksvägen 2, S-141 41 Huddinge (SE). (74) Agent: FÖRSVARETS MATERIELVERK; Patentenheten, S-115 88 Stockholm (SE).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>In English translation (filed in Swedish).</i>
(54) Title: MELT CAST CHARGES (57) Abstract The invention relates to a method of manufacturing melt cast charges, e.g. shaped charges, comprising suspension of an explosive component in a molten component serving as a matrix. The invention is characterised in that ADN (ammonium dinitramide) is used as a matrix. The invention also concerns a melt cast charge comprising a matrix of ADN, in which an explosive has been suspended, selected from the group consisting of RDX, HMX, HNIW and mixtures thereof.		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

Melt Cast Charges

The invention relates to a method of manufacturing melt cast charges comprising suspension of an explosive component in a molten component serving as a matrix,
5 and new charges manufactured in accordance with the method.

Melt cast charges are commonly used as explosive charges in shells and mines. Casting is a simple and inexpensive method of manufacturing also charges of a complicated design, e.g. shaped charges, directly in a shell body. Melt cast charges
10 are also relatively easy to scrap by melting out the charge.

TNT (2,4,6-trinitrotoluene) is the explosive which has mainly been used in melt cast charges. TNT is stable, insensitive and has a low melting point (80°C), but has relatively poor performance and a strongly negative oxygen balance (-73.9%). Explosives having higher performance, such as RDX and HMX, have therefore been
15 suspended in molten TNT, which thus has served as a matrix, thereby obtaining castable mixed explosives. Also a number of other products can be mixed with molten TNT to obtain castable explosive charges for special purposes, e.g. aluminium powder for charges having high efficiency.

20 One object of the present invention is to provide melt cast charges with improved performance. A further object is to use a new matrix which replaces TNT in the manufacture of melt cast charges, but which at the same time allows essentially the same processes and process equipment to be used in the manufacture of the
25 charges.

According to the invention, ADN (ammonium dinitramide) is used as a matrix. The preparation of ADN is disclosed in e.g. WO 91/19669, WO 91/19670, WO 93/16002 and WO 97/06099.

30 The invention also relates to a melt cast charge comprising a matrix of ADN, in which an explosive has been suspended, selected from the group consisting of RDX, HMX, HNIW and mixtures thereof.

35 HNIW, or CL-20 as it is also referred to, is hexanitrohexaazaisowurtzitane. A method of preparing HNIW is disclosed in e.g. WO 97/00873. HNIW has no melting point and decomposes at about 230°C.

Melt cast charges of mixed explosives, in which TNT is used as a matrix, are well known and have long been used in military applications. Examples of such mixed explosives are TNT/RDX (Cyclotol, Hexotol, Comp. B, HT); TNT/HMX (Octol);
5 TNT/RDX/Al (Hexotonal, Torpex, Trialene, HTA, HBX-1, HBX-3, H-6); TNT/HMX/Al (Octonal, HTA-3); TNT/RDX/HMX; TNT/RDX/HMX/Al.

According to the invention, ADN (ammonium dinitramide) can replace TNT as a matrix in such charges and result in a mixed explosive with improved performance.
10 TNT has a melting point of about 80°C and ADN a melting point of 92°C. The difference in melting point is not greater than to allow the use of essentially the same manufacturing processes when the charges are manufactured by using the new matrix.

15 The detonation performance for pure ADN is somewhat lower than for TNT, but mixtures of ADN and HMX, RDX, HNIW etc. result in considerably higher performance than do mixtures of the corresponding explosive and TNT.

The new method is especially well suited for manufacturing shaped charges, where
20 the melt/cast technique has great advantages while at the same time it is desirable to achieve higher performance of the charges.

Theoretical calculations of detonation performance in shaped charge applications for different mixtures have been carried out by using the program Cheetah, the
25 detonation performance for HMX being used as a basis of calculation and being set to 100%. The result is shown in the following Table:

Explosive	Mixture, weight%/weight%	Performance, % of HMX
TNT/RDX	30/70	80
TNT/HMX	30/70	85
ADN/RDX	30/70	95
ADN/HMX	30/70	101
ADN/HNIW	30/70	112

A mixture of ADN/HMX 30/70 has the same performance as pure HMX, i.e. HMX
30 can be melt cast without loss of performance by using ADN as a matrix.

The performance values in the Table relate to mixtures, i.e. for ADN/HNIW (ADN/CL-20) if HNIW is suspended in molten ADN. As described in Swedish Patent Application 9701394-0, HNIW can also be dissolved in molten ADN, thereby obtaining a complex of ADN and HNIW. The performance for the complex is higher than for the mixture.

In the charges, aluminium powder and other additives can be mixed in the same way as is known from the manufacture of charges using TNT as a matrix. When aluminised charges are manufactured, the explosive can first be granulated with aluminium powder, for instance as described in US 4,376,083, before being mixed with the matrix.

The invention will now be described by way of Examples.

Example 1

3 g ADN were melted in a small steel cup provided with a thermostat and internally coated with Teflon. The thermostat was set at 105°C. 6 g HMX (200 µm) were added and mixed with the melt. A small stainless steel anchor was dropped into the mixture. The sample was cooled by setting the thermostat at 94°C for about 7 min and then switching it off completely. When the sample had cooled, it was carefully withdrawn from the cup by means of the anchor.

The test was repeated while adding RDX and mixtures of HMX and RDX to molten ADN.

The samples were analysed by DSC. No complex formation or exotherms owing to compatibility problems could be observed. Moreover, no change could be noted, either of the ADN matrix or of the admixed explosives when dividing the cast samples.

Example 2

3 g ADN were melted in the same way as in Example 1, and 6 g HNIW were added and mixed with the melt. The mixing was carried out relatively quickly to avoid that

HNIW dissolved in the melt to any considerable extent. The sample was cooled by shutting off the thermostat.

The sample was analysed by DSC. At 92 °C, the ADN phase melted while the
5 HNIW crystals seemed to be unaffected.

Claims:

1. A method of manufacturing melt cast charges, comprising suspension of an
5 explosive component in a molten component serving as a matrix, characterised in
that the molten component is ADN.
2. A method as claimed in claim 1, characterised in that the charges are shaped
charges.
- 10 3. A melt cast charge, characterised in that it comprises a matrix of ADN, in which
an explosive has been suspended, selected from the group consisting of RDX,
HMX, HNIW and mixtures thereof.
- 15 4. A melt cast charge as claimed in claim 3, characterised in that it contains alumi-
nium powder.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/00775

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C06B 45/04, C06B 25/34, F42B 1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C06B, C06D, F42B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

STN: REGISTRY, CA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5468313 A (INGVAR A. WALLACE, II ET AL), 21 November 1995 (21.11.95), column 1, line 9; column 3, line 16 - line 23; column 4, line 10 - line 29, column 4, line 31 - line 47; column 4, line 48 - line 58 --	1-4
A	WO 9706099 A1 (FÖRSVARETS FORSKNINGSANSTALT), 20 February 1997 (20.02.97), claims 1,9 --	1-4
A	WO 9700873 A1 (THIOLKOL CORPORATION), 9 January 1997 (09.01.97), column 1, line 12 - line 27, claim 1 --	1-4

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

5 August 1998

Date of mailing of the international search report

10 August 1998 (10.08.98)

Name and mailing address of the ISA/

Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Bengt Christensson
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE 98/00775

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
US	5468313	A	21/11/95	NONE	
WO	9706099	A1	20/02/97	AU 6539696 A EP 0843647 A NO 980534 A SE 9502783 D SE 9503326 A	05/03/97 27/05/98 06/02/98 00/00/00 09/02/97
WO	9700873	A1	09/01/97	AU 6180896 A NO 975869 A US 5723604 A	22/01/97 12/12/97 03/03/98
US	4376083	A	08/03/83	CA 1172454 A EP 0035376 A,B SE 0035376 T3 PT 72476 B	14/08/84 09/09/81 04/02/82

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 98/00775

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p data-bbox="396 415 1016 478">US 4376083 A (KARE ULSTEEN), 8 March 1983 (08.03.83), claim 1</p> <p data-bbox="716 516 834 558">-- -----</p>	1-4